ID 968

WHAT DO WE KNOW ABOUT THE EFFECTS OF FORESTATION ON SOIL- AND WATER-RELATED ECOSYSTEM SERVICES IN THE ANDES?

PhD. Vivien BONNESOEUR[1], PhD. Bruno Locatelli[1], PhD. Manuel Guariguata[1], Mr. Boris Ochoa-Tocachi [1], PhD. Veerle Vanacker[2] , PhD. Zhun Mao[3], PhD. Alexia Stokes [3]
[1] Center for International Forestry Research (CIFOR) – PERU
[2] Université Catholique de Louvain
[3] Institut National de Recherche Agronomique (INRA)

Several Andean countries have planned to restore forest cover in degraded and deforested land to enhance the provision of ecosystem services to society. In the Andean region, reduced water availability has been attributed to past forestation with exotic species thus fueling debate. Whereas the impact of forestation on water supply and regulation has been largely studied worldwide, critical information is missing in the context of Andean ecosystems where water scarcity is common along with steep terrain that favors soil erosion and landslides. To inform sound decision-making on forestation, we reviewed scientific evidence on the impact of forestation on water supply, water flow regulation, and soil erosion in the Andes. Following systematic review protocols, we searched peer-reviewed articles and unpublished thesis and reports. We synthesized studies using different methods, including meta-analyses and meta-regression. Forestation had clear positive impacts in degraded soils, through reducing soil erosion, increasing water infiltration, and improving low flows. However, total water supply was reduced by increased evapotranspiration of tree cover. At high elevations, restoration of Andean grasslands led to better hydrological outcomes than forestation. This is due to the good hydrological properties of grasslands and the detrimental effects of replacing them by exotic tree plantations. Forestation significantly reduced soil organic matter (an indicator of hydrological services and erosion regulation). However, land-use history before forestation had more effect on soil organic matter than, for example, management type, species planted, or age since planting. Important knowledge gaps include the impact of forestation on landslides susceptibility, water use efficiency, and potential differences in the impact of forestation between native and exotic species.

CORRESPONDING AUTHOR: PhD. Vivien BONNESOEUR – PERU - V.Bonnesoeur@cgiar.org

JOINT
CONFERENCE ON
FORESTS AND WATER 2018

05 – 08.11.2018

Proceedings Book 2018

JOINT CONFERENCE ON FORESTS AND WATER 2018

05 — 08.11.2018

Universidad Austral de Chile

— Valdivia —

PROGRAM

II Congreso
Latinoamericano Bosques y Agua

V IUFRO
Conference on Forests and Water
in a Changing Environment

What do we know about the effects of forestation on soil- and water-related ecosystem services in the Andes?

Foto: B. Locatelli

Vivien Bonnesoeur[1], Bruno Locatelli [1,2,3]

1 CIFOR

2 UNIVERSITÉ DE MONTPELLIER

3 cirad

Lima Hub, Perú

Hydrological services sustain the live of more than 50 millions Andean people.

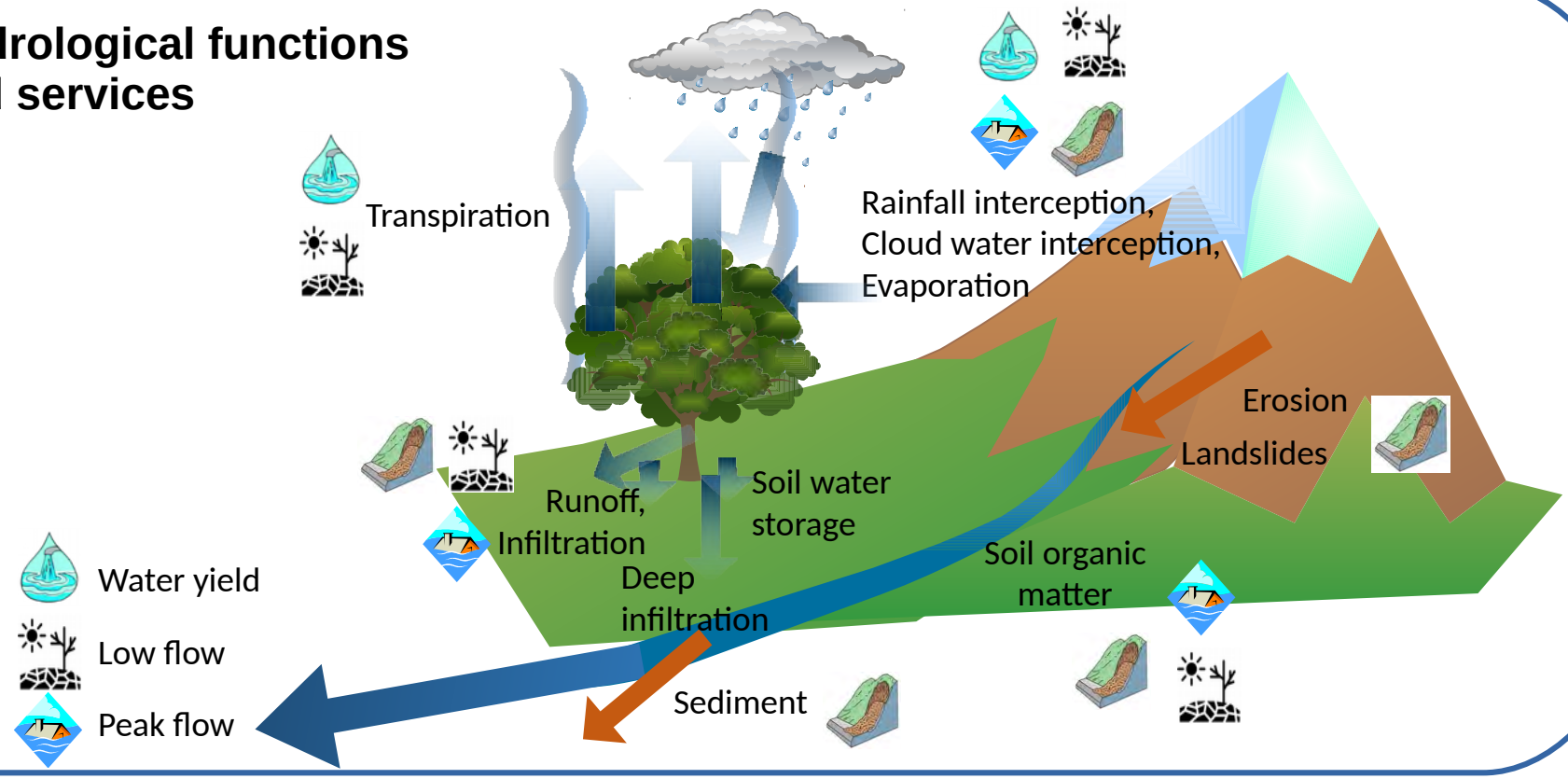
Provision of water (total amount)

Preservation of low flows during dry season

Control of peak flows during strong rainfall events

Control of erosion (diffuse / mass-wasting)

Hydrological functions and services



Forestation and Forest restoration: A strong interest in the region

Forest Landscape restoration : Process of regaining ecological functionality and enhancing human well-being across whole deforested or degraded landscapes. It is **more than replanting trees** ; it is an implementation vehicle for national priorities such as boosting landscape productivity, **improving water** and food security, **conserving biodiversity**, and combating desertification and **adapting to climate changes**…

Imagen: https://www.iucn.org/es/regiones/américa-del-sur/nuestros-proyectos/proyectos-en-ejecución/restauración-de-paisajes-forestales-flr-perú

Imagen: http://www.iufro.org/download/file/25537/6368/105_Initiative20x20_IUFRO_SV_pdf/

Need of synthesizing existent scientific evidences to inform policymakers about the forestation impacts on the hydrological services in the Andes.

Imagen: http://www.serfor.gob.pe/noticias/gestion-forestal/comunidades-campesinas-de-huancavelica-plantan-mas-de-dos-mil-pinos-para-superar-sequia

Methods

- Systematic review
  - Search in database and Andean universities
  - >6000 hits
  - 149 selected studies
- Quantitative synthesis :
  - Meta-analysis
  - Meta-regression

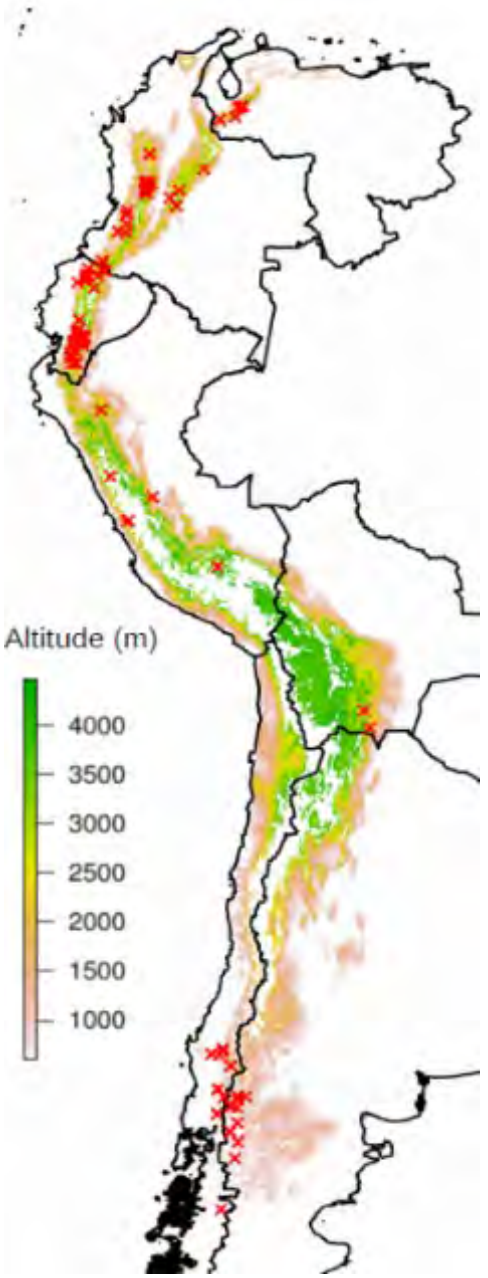
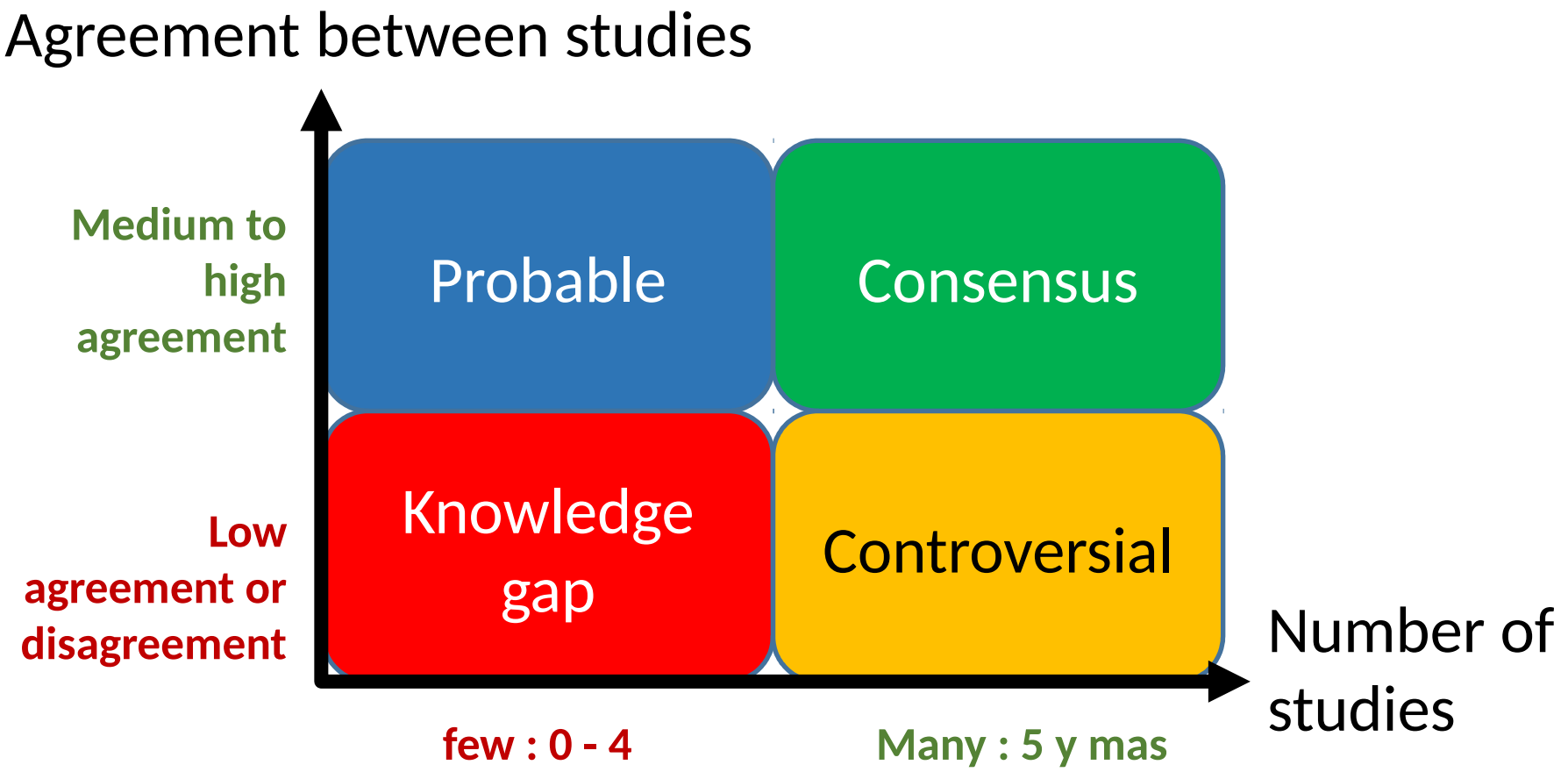


Imagen: http://cccrg.cochrane.org/infographics

Results

Level of confidence for the evidences on the different impact

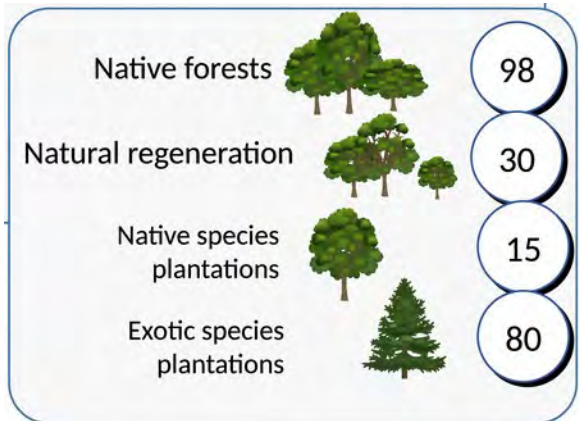


Key consensual messages for policy makers

- Exotic tree plantations needs important quantity of water and therefore often reduce the total water supply to downstream users in most Andean regions.
  - Forestation projects, especially large ones, must acknowledge this
- When forestation, including with exotic species, occurs on degraded soils, they can control diffuse erosion and improve hydrological regulation.
  - Priority area of forestation should be defined
- Exotic tree plantations on well-conserved grasslands (e.g. páramos/puna) have detrimental impacts on total water supply and hydrological regulation.
- Existing native forests provide excellent water regulation and erosion control, especially in cloud-affected regions.
  - A portfolio of actions must include forestation but also native grassland restoration, native forest conservation, etc.

Knowledge gaps

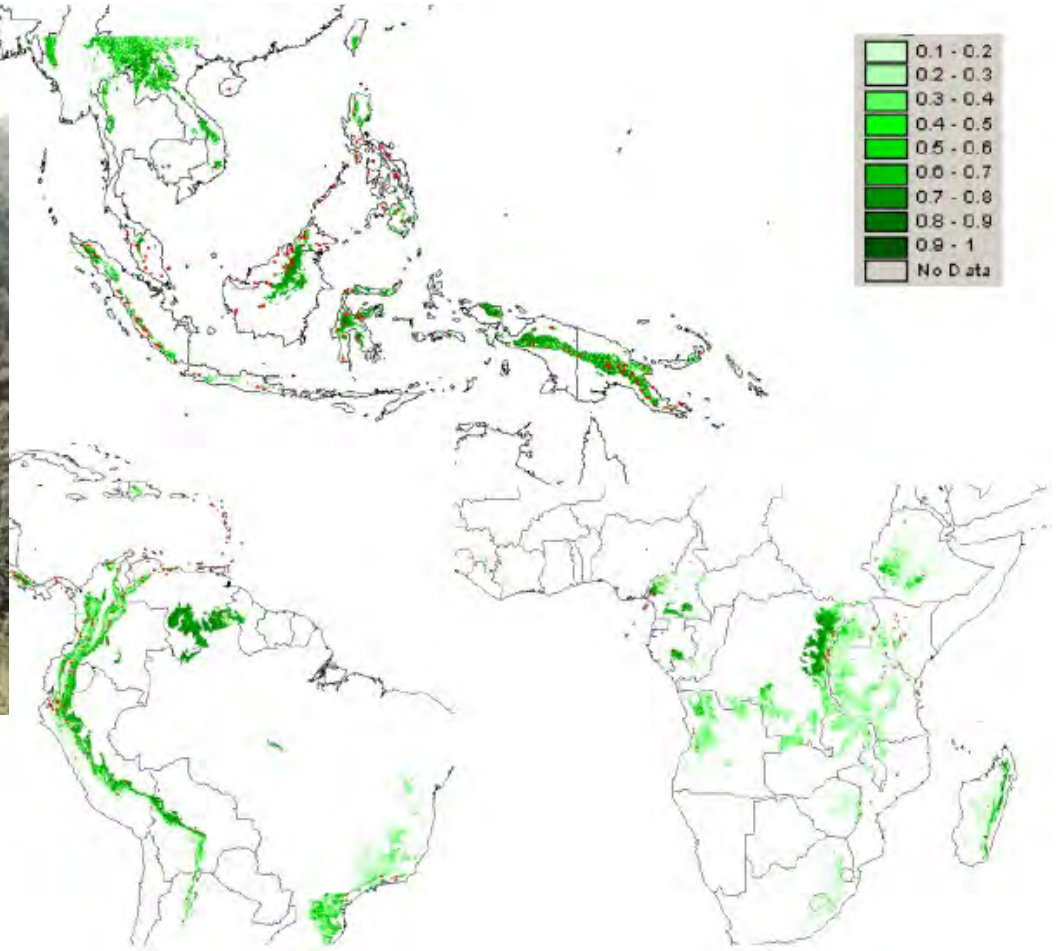
Impact of forestation with native species (plantation & natural regeneration)



Knowledge gaps

Impact of exotic tree plantation in cloud-affected regions

Bosque de Polylepis subtusalbida con Eucalyptus globulus en el Parque Nacional Tunari-Cochabamba, Bolivia (*Navarro et al., 2010*)



Knowledge gaps

Impact of exotic tree plantation on landslides

Knowledge gaps

Trade-offs between hydrological services and other ecosystem services

Ecología Austral 21:271-284. Diciembre 2011
Asociación Argentina de Ecología

Sección especial

Uso del agua y productividad de los bosques nativos e implantados en el NO de la Patagonia: aproximaciones desde la ecohidrología y la ecofisiología

JAVIER E. GYENGE[1,2,✉], M. ELENA FERNÁNDEZ[1,2], JULIÁN LICATA[3], MARIANA WEIGANDT[2], BARBARA J. BOND[4] & TOMÁS M. SCHLICHTER[2]

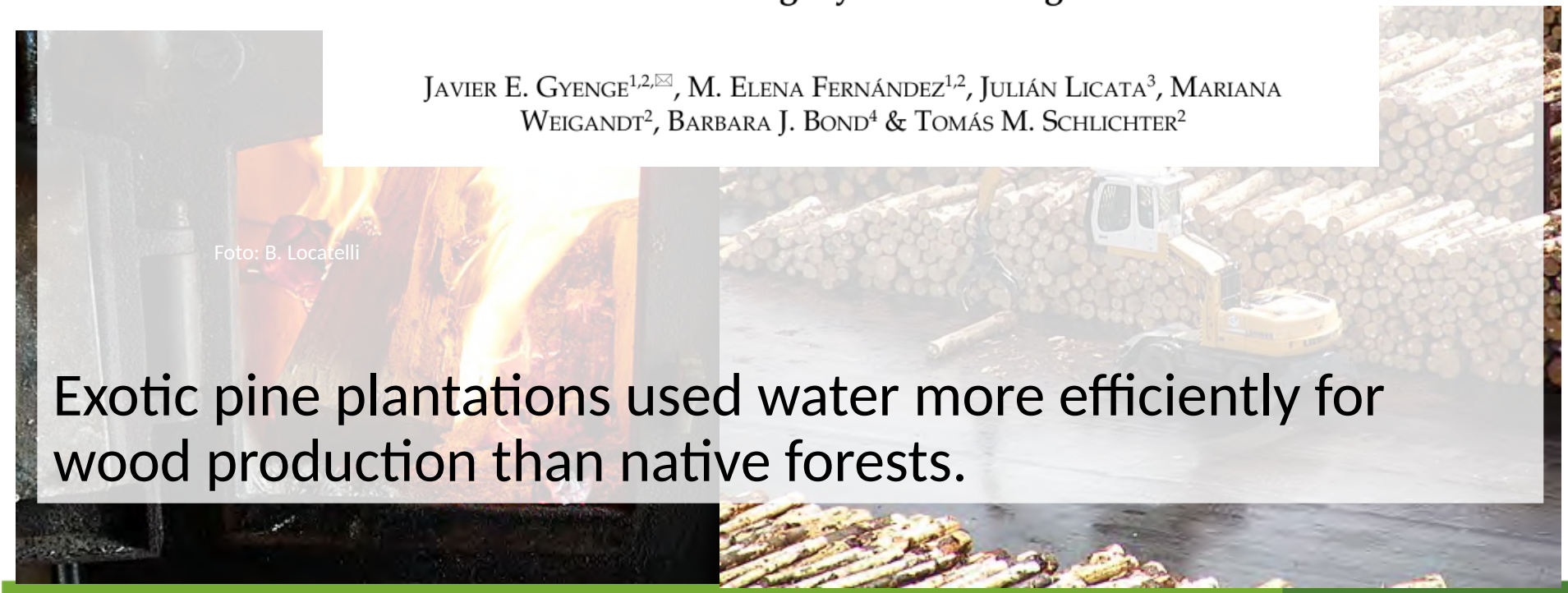


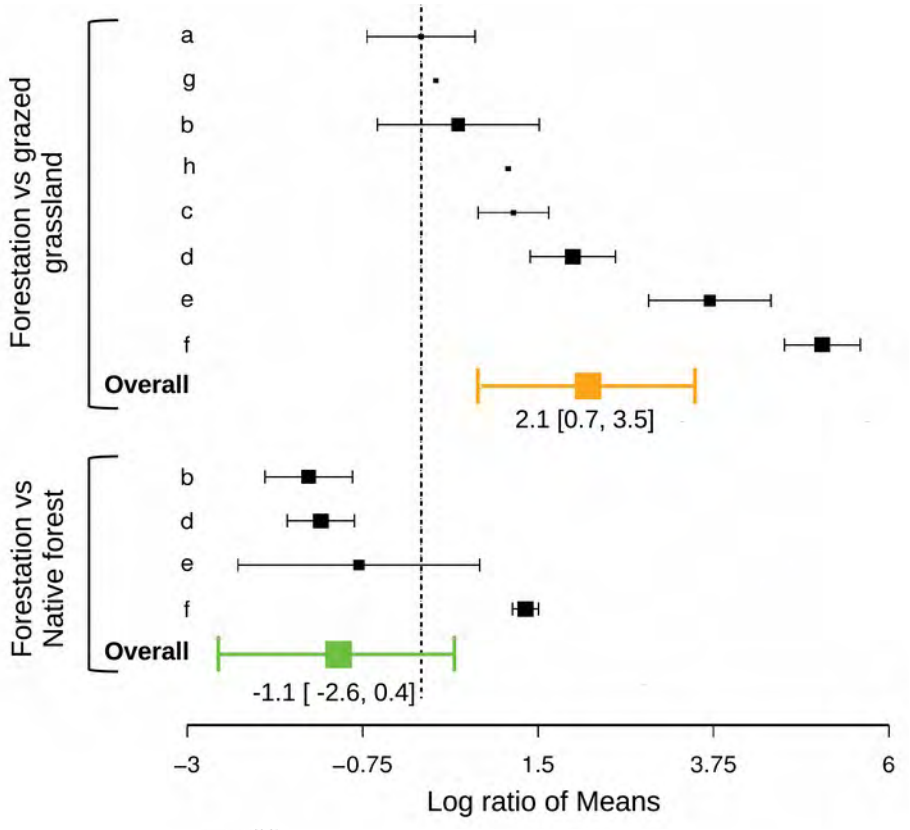
Foto: B. Locatelli

Exotic pine plantations used water more efficiently for wood production than native forests.

Controversial

Forestation on degraded soils allows to increase base flow during dry season

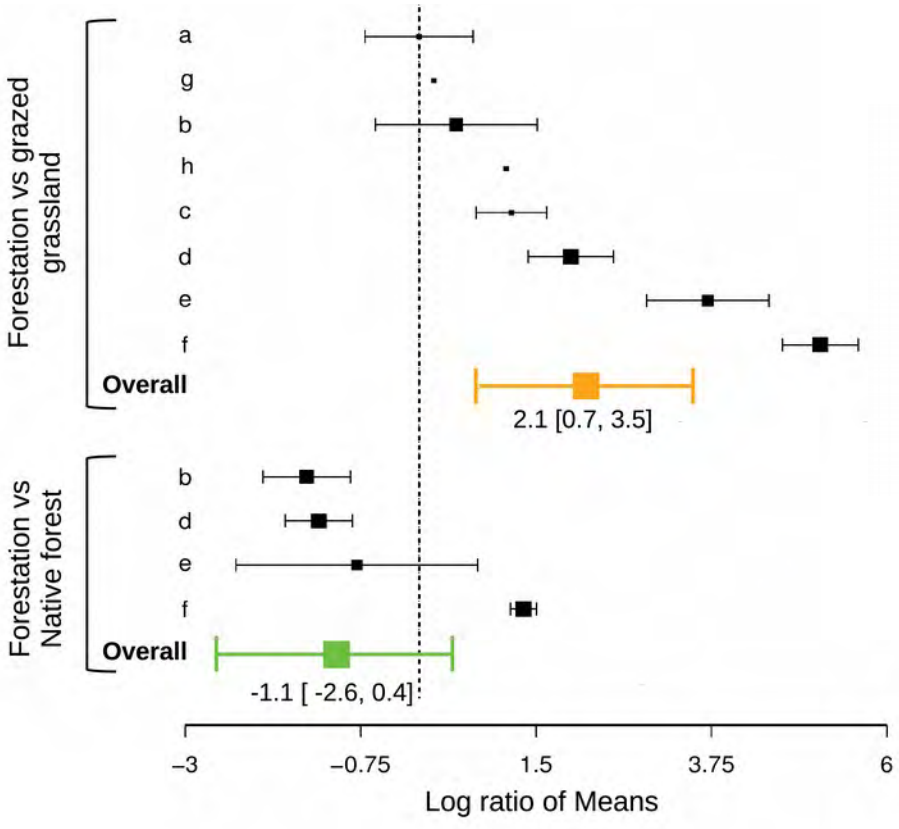
8 times increase in infiltration rate when tree planted on (over)grazed grasslands



Controversial

Forestation on degraded soils allows to increase base flow during dry season

8 times increase in infiltration rate when tree planted on (over)grazed grasslands



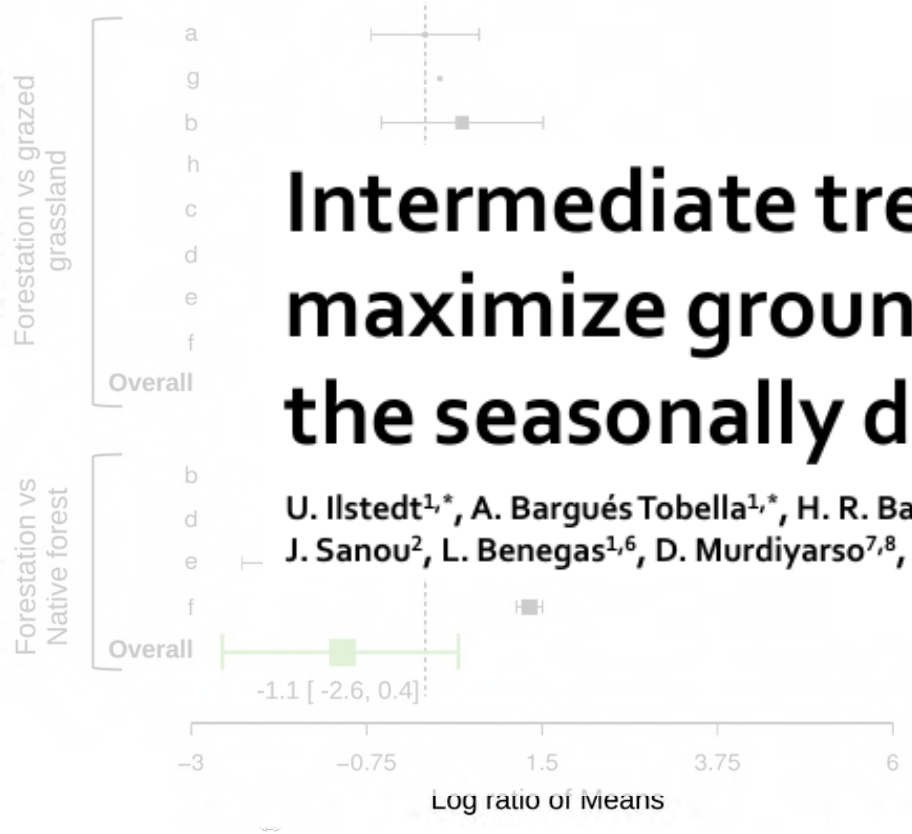
??

Evapotranspiration

Controversial

Forestation on degraded soils allows to increase base flow during dry season

8 times increase in infiltration rate when tree planted on (over)grazed grasslands



Intermediate tree cover can maximize groundwater recharge in the seasonally dry tropics

U. Ilstedt[1,*], A. Bargués Tobella[1,*], H. R. Bazié[2,3], J. Bayala[4], E. Verbeeten[5], G. Nyberg[1,11], J. Sanou[2], L. Benegas[1,6], D. Murdiyarso[7,8], H. Laudon[1], D. Sheil[8,9,10] & A. Malmer[1]

??

Evapotrans

n

Conclusions

- Forestation is beneficial for controlling diffuse erosion and improving hydrological regulation on Andean degraded soils.
- Important knowledge gaps to address in futures studies
- Need to create or amplify existent hydrological monitoring network (e.g. iMHEA)

Contact: V.Bonnesoeur@cgiar.org; bruno.locatelli@cirad.fr

Financiamiento:

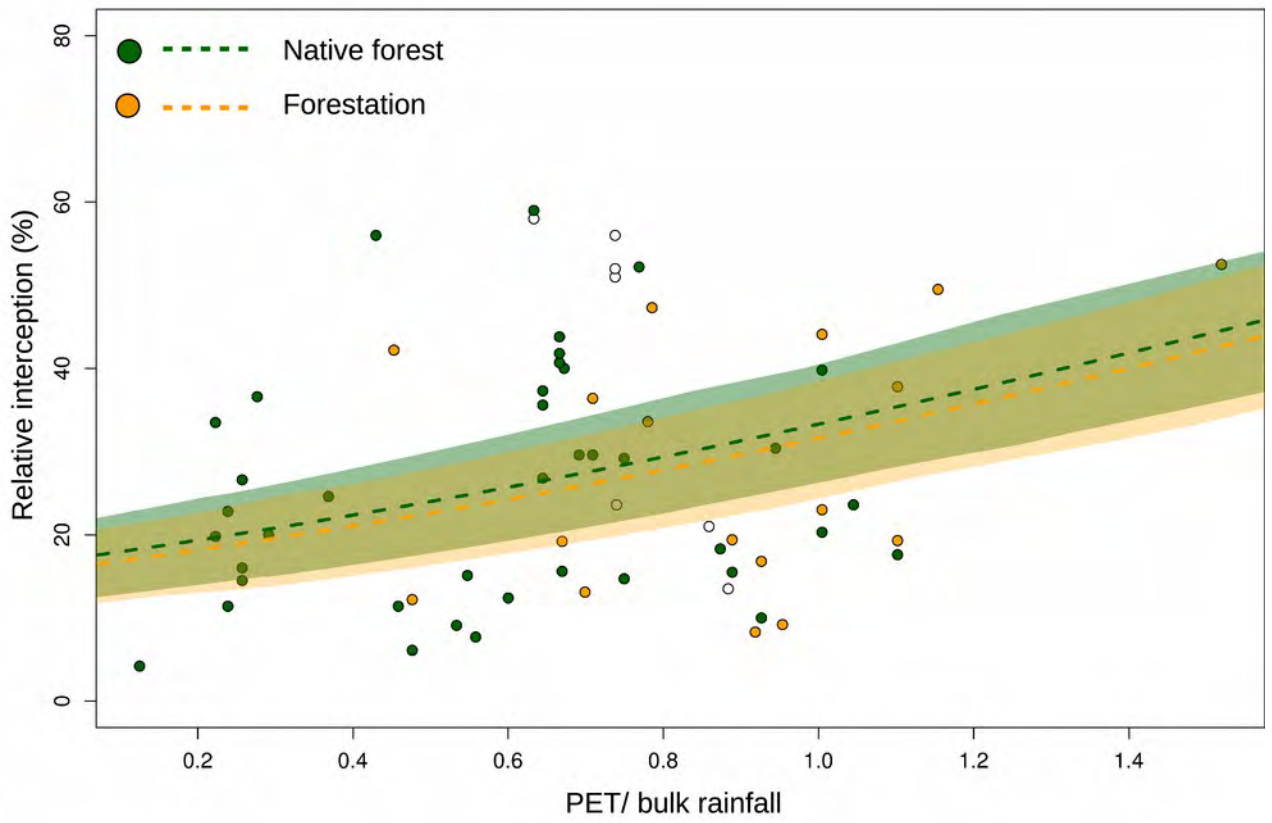
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

Norad

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

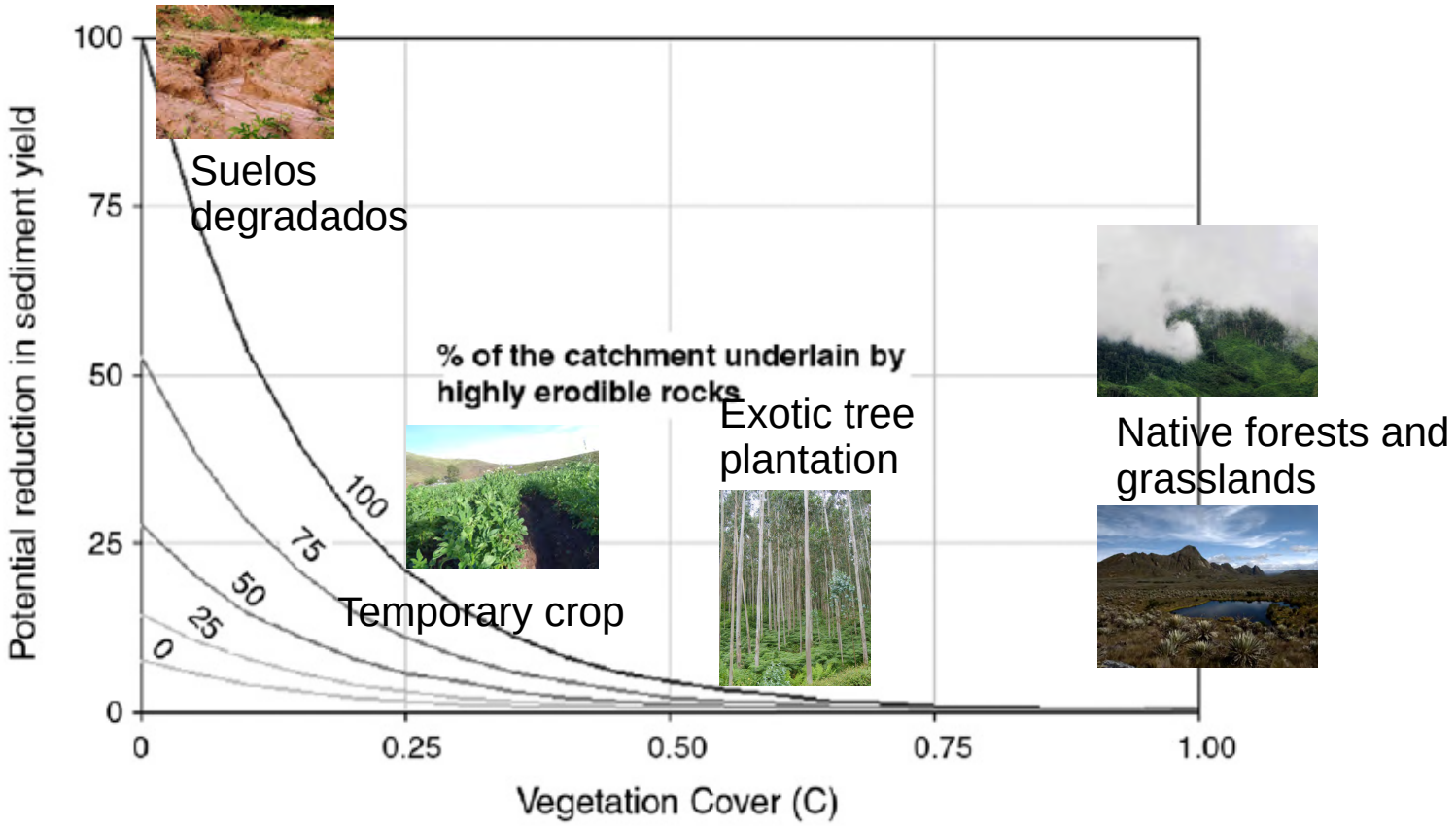
Brechas de conocimiento

Trade-off entre servicios ecosistémicos hídricos y otros servicios ecosistémicos



Resultados consensuales sobre erosión de suelos

Importancia de la cobertura superficial del suelo



Molina et al., 2007

Natural Extensive Intensive Degraded

Forested land

Native Forest

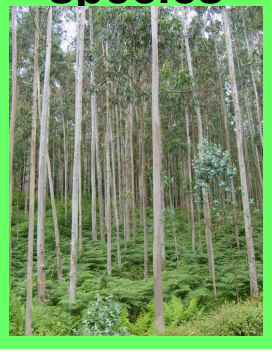
Forestation

Natural regeneration of forest

Tree plantation

native species

Exotic species



Degraded soil

Non-forested land

Well conserved grassland

Grazed

Agricultural